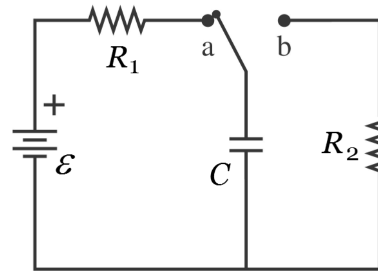
PHYS 2212

Recitation 08 March 15-18

Example

The capacitor in the illustrated circuit is initially uncharged. The switch is placed in position a for $20\,\mu$s, then thrown to position b. What is the current through the resistor R_2 $10\,\mu$s after the switch is in position b? $\mathcal{E} = 9.0\,\mathrm{V}$, $C = 1.0\,\mu\mathrm{F}$, $R_1 = 20\,\Omega$, and $R_2 = 10\,\Omega$.

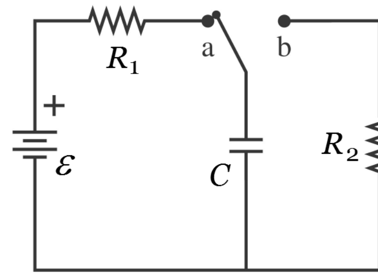


PHYS 2212 Section: ______ Name: ______________________

Recitation 08 March 15-18

Problem

The capacitor in the illustrated circuit is initially uncharged. The switch is placed in position a for 2.0 ms, then thrown to position b. How much energy is dissipated in the resistor R_2 during the first 4.0 ms that the switch is in position b? $\mathcal{E} = 50\,\mathrm{V}$, $C = 20\,\mu\mathrm{F}$, $R_1 = 200\,\Omega$, and $R_2 = 100\,\Omega$.



PHYS 2212 **Solution**
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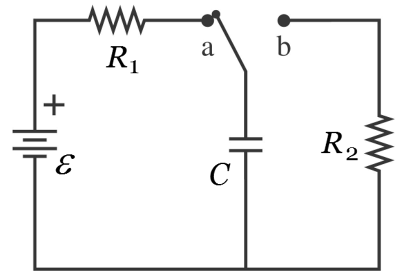
Example

The capacitor in the illustrated circuit is initially uncharged. The switch is placed in position a for $20\,\mu$s, then thrown to position b. What is the current through the resistor R_2 $10\,\mu$s after the switch is in position b? $\mathcal{E} = 9.0\,$V, $C = 1.0\,\mu$F, $R_1 = 20\,\Omega$, and $R_2 = 10\,\Omega$.



While the switch is in position a:

$$\tau_1 = R_1 C = 20\,\Omega \cdot 1\,\mu F = 20\,\mu s$$

$$Q = Q_0 (1 - e^{-\frac{t}{\tau}})$$

$$= CV(1 - e^{-\frac{20\mu s}{20\mu s}}) = 1\mu F \cdot 9V (1 - e^{-1})$$

$$= 9\mu C (1 - e^{-1})$$

$$= 9(1 - e^{-1})\,\mu C.$$

While the switch is in position b:

$$Q' = Q e^{-\frac{t}{\tau_2}} \qquad (\tau_2 = R_2 C = 10\,\Omega \cdot 1\,\mu F = 10\,\mu s)$$

$$= (9(1 - e^{-1})\mu C) \cdot e^{-\frac{10\mu s}{10\mu s}}$$

$$= 9(1 - e^{-1}) e^{-1}\,\mu C = 2.09\,\mu C$$

$$I = \frac{dQ'}{dt} = \left(-\frac{1}{\tau_2}\right) Q e^{-\frac{t}{\tau_2}}\Big|_{t = 10\mu s} = \left(-\frac{1}{10\mu s}\right)(9(1 - e^{-1})\mu C)\, e^{-\frac{10\mu s}{10\mu s}}$$

$$= 0.209\,\frac{C}{s} = 0.209\,A$$

PHYS 2212 **Solution**
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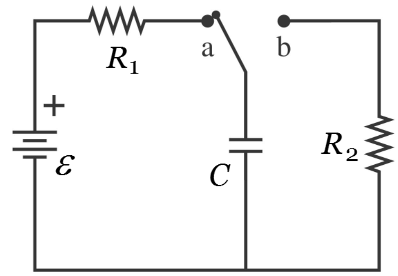
Problem

The capacitor in the illustrated circuit is initially uncharged. The switch is placed in position *a* for 2.0 ms, then thrown to position *b*. How much energy is dissipated in the resistor R_2 during the first 4.0 ms that the switch is in position *b*? $\mathcal{E} = 50\,\text{V}$, $C = 20\,\mu\text{F}$, $R_1 = 200\,\Omega$, and $R_2 = 100\,\Omega$.



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when Swith is on a.

$$\tau_1 = R_1 C = 200\,\Omega \cdot 20\,\mu F = 4000\,\mu s = 4\,ms$$

$$Q = Q_0\left(1 - e^{-\frac{t}{\tau_1}}\right) = C\mathcal{E}\left(1 - e^{-\frac{t}{\tau}}\right)$$

$$= 20\,\mu F \cdot 50\,V \left(1 - e^{-\frac{1}{2}}\right)$$

$$= 1000\,\mu C\left(1 - e^{-\frac{1}{2}}\right)$$

When suthe on b.

$$Q' = Q e^{-\frac{t}{\tau_2}} = Q e^{-\frac{t}{R_2 C}} = Q e^{-\frac{4\,ms}{100\,\Omega \cdot 20\,\mu F}}$$

$$= Q e^{-2}$$

$$\Delta E = \frac{1}{2}\frac{Q^2}{C} - \frac{1}{2}\frac{Q'^2}{C} = \frac{1}{2}\frac{Q^2}{C}\left(1 - (e^{-2})^2\right)$$

$$= \frac{1}{2}\frac{(1 - e^{-4})}{C}\left(1000\,\mu C\left(1 - e^{-\frac{1}{2}}\right)\right)^2$$

$$= \frac{1}{2}\frac{(1 - e^{-4})\left(1000\,\mu C\left(1 - e^{-\frac{1}{2}}\right)\right)^2}{20\,\mu F}$$

$$\Delta E = \frac{1}{2}\frac{0.1519\,\text{C}^2}{20\,\text{F}} = 0.0038\,\text{J}$$